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# **PART I**

## ***STORM DRAINAGE CRITERIA***

### **SECTION 1: DRAINAGE POLICY**

#### **1.1 Statement Of Policy**

The purpose of the Storm Drainage Report and design shall be to prevent loss or damage of property due to increased storm water runoff from proposed development. The scope of such reports and designs shall consider both property within the development and property adjacent to and downstream of the development.

Whenever possible master drainage studies should be referenced for proposed developments located within the basin boundaries of such studies. Release rates and regional drainage information from master drainage studies should be analyzed to assist in the storm drainage design for proposed developments. This information is particularly helpful in identifying drainage-related constraints for areas within the master drainage study boundaries. It will be the policy of the Town of Firestone that sufficient data be collected to analyze drainage effects by a proposed development in the absence of a master drainage study.

Utilization of existing irrigation ditches as conveyance elements in the drainage design will not be allowed in general. Some exceptions may occur but only at the discretion of the Town and with the express written permission of the Ditch Company. In no event shall discharge of developed runoff be allowed into an irrigation ditch that would carry the runoff into another local basin. In evaluating offsite runoff that contributes to the site, the Engineer shall consider the effects of manmade structures or grading that have un-naturally modified the historic runoff path. Runoff from property that has been un-naturally diverted or retained shall be considered, ignoring the manmade obstruction.

The Firestone area has several sink hole and prairie kettle features. In many cases, these are naturally formed sumps. In other cases runoff has been trapped by the construction of roads, berms, or other manmade structures. Some areas have been intentionally graded to retain runoff for agricultural advantage. In the case of a naturally formed sump the Engineer shall show that the sump can contain the 100-yr event developed runoff from the entire contributing basin with a reasonable amount of excess capacity to account for a partially filled sump prior to the 100-yr event. Water quality and the effect of the sump on surrounding development (current or future) shall also be considered. The design must show that the sump will not create a nuisance caused by increased runoff volumes caused by development. If these conditions can not be met to the satisfaction of the Town, the Town may require that a conveyance be installed to drain the sump. In the case of a manmade impediment, the design shall eliminate the sump and convey the runoff to the nearest major basin drainageway.

#### **1.2 Town Jurisdiction**

The Weld County Tri-Area Sanitation District has undertaken responsibility for storm drainage within their service area. All development within the District shall, at a minimum, comply with the Storm Drainage Design Criteria published by the District. The Town of Firestone reserves the

right to require more stringent design and/or construction standards if in the best interests of the public. The criteria set forth in PART I shall apply to development in the Town of Firestone, outside of the Weld County Tri-Area Sanitation District boundaries.

The formation of a new drainage district called the “Southwest Weld Drainage Authority” is in process. Their criteria and involvement in the development process has not been finalized and is not available to the Town of Firestone at the time of this update. Be advised that an additional governing entity may be involved in some capacity in the near future.

The Design Criteria and Construction Standards set forth in this section are considered minimum requirements. The Town may, at its discretion, require additional information and conditions, in some cases making requirements more “strict” to best serve the interests of the public and the Town. These criteria and standards are general in nature and the Town reserves the right to alter or add to them based on site-specific issues.

### **1.3 Design Criteria & Water Quality**

Design criteria in Part I is to provide the people of the Town of Firestone and the general public with safe, economical and technically proficient drainage facilities.

The Engineer is to use published material by a generally accepted authoritative source such as the Urban Drainage and Flood Control District. The material used must be referenced and applicable parts copied as part of the submittal information. Rational method hydrologic analysis is acceptable in most cases. The Engineer may choose to utilize a computer generated storm water hydrology model as long as it can be demonstrated to the satisfaction of the Town that the modeling methodology is applicable to the conditions.

Approval of the final storm drainage report and construction plan will be required prior to approval of the final construction plans and recording of the final plat. The drainage system shall be designed to consider the drainage basin as a whole and shall accommodate not only runoff from the development area but also, where applicable, the system shall be designed to accommodate the runoff from those areas adjacent to and upstream from the development itself, as well as its effects on property downstream.

The design and operation of a proposed development shall ensure the following:

- A. Historic flow patterns and runoff amounts will be maintained in such a manner that will reasonably preserve the natural character of the area and prevent property damage of the type generally attributed to runoff rate and velocity increases, diversions, and/or concentration of storm runoff;
- B. The development will not impede the flow of natural watercourses;
- C. All low points within the proposed development site will have adequate facilities to intercept and convey the 100-yr event developed runoff as well as provide emergency conveyances to direct runoff to downstream facilities in the event of plugging or larger event storms;

- D. Any drainage system proposed as part of any development proposal is based on consideration of the drainage basin as a whole and is capable of accommodating not only runoff from the proposed development, but also, where applicable, the historic runoff from areas adjacent to and "upstream" from the development proposal;
- E. Provision exists in the design or operation of any proposed drainage facilities to ensure suitable provisions for maintenance. The Owner/Homeowners Association shall be responsible for maintaining all storm drainage facilities unless a written agreement is made between the Developer and the Town;
- F. All development shall meet the requirements of storm water quality dictated by the Colorado Department of Health and the EPA's NPDES Permit. Appropriate erosion and sediment control devices shall be incorporated in the design and construction.

## **SECTION 2: SUBMITTAL REQUIREMENTS**

### **2.1 Preliminary Drainage Report**

The purpose of the preliminary drainage report is to identify and define conceptual solutions to existing problems or problems that will occur as a result of the proposed development. The preliminary drainage assessment shall be in accordance with the following outline and contain the applicable information listed. Failure to comply with the provisions of this section may result in the report being rejected for review.

#### **2.1.1 Description Of Site**

A general legal description for the proposed development shall be stated in the introduction. The general location of the proposed development with respect to adjacent public or private roads shall be described. All existing land uses adjacent to the proposed development shall be described. A general location map shall be provided in sufficient detail to depict general drainage patterns and identify drainage flows entering and leaving the proposed development. USGS maps are acceptable for this map. The map shall be at a scale of 1-inch equal's 1000 feet to 1-inch equal's 8000 feet. The map shall identify any existing improvements (i.e., development, irrigation ditches, existing detention facilities, culverts, and storm sewers) that will influence or be influenced by the proposed development.

The general description of the proposed development property shall include at a minimum:

- A. Area in acres.
- B. Township, Range, Section,  $\frac{1}{4}$  section
- C. Local streets, within and adjacent to the subdivision
- D. Existing and proposed ground cover (type of trees, shrubs, vegetation).
- E. General topography.
- F. General soil conditions.

- G. Irrigation ditches or laterals.
- H. Existing and proposed drainage ways.

#### **2.1.2 Description Of Basin And Sub-basins**

- A. The reference of any major drainage way planning study, such as master drainage basin planning studies, flood hazard delineation reports, and flood insurance studies or maps, if available.
- B. The “South Weld I-25 Corridor Master Drainage Plan”, completed by Anderson Consulting Engineers, February 17, 2000, is a Master Drainage Plan that analyzes two large existing basins (the Godding Hollow Basin and the Tri-Town Basin) surrounding the Firestone/Frederick area. This study should be referenced in submittals to the Town for developments that fall inside these Basins area.
- C. A discussion of major basin drainage characteristics.
- D. Identification of all nearby irrigation ditches, laterals, streams, rivers, or wetlands, which will influence or be influenced by the local drainage.
- E. A discussion of the historic drainage pattern of the proposed development property.
- F. A discussion of off-site drainage flow patterns and impact on the proposed development.

#### **2.1.3 Drainage Design Criteria**

- A. Calculate peak runoff for the 2 –yr, 10-yr, and 100 – yr recurrence intervals.
- B. Discuss runoff calculation method used and explain any assumptions used within the chosen method (runoff coefficients, times of concentration, curve numbers, etc...).
- C. Calculate preliminary detention facility storage requirements and release rates.

#### **2.1.4 Drainage Facility Design**

- A. A discussion of compliance with off-site runoff considerations;
- B. A discussion of anticipated and proposed drainage patterns;
- C. A discussion of the tables, charts, figures or drawings presented in the report;
- D. A presentation of existing and proposed hydrologic conditions with approximate flow rates entering and exiting the proposed development with all necessary preliminary calculations;
- E. A presentation of approach to accommodate drainage impacts on existing or proposed improvements and facilities;



- F. A presentation of proposed drainage facilities with respect to alignment, material, and structure type including preliminary detention pond sizing. Sizing inlets and conveyance elements is not required with the preliminary drainage report;
- G. A discussion of long-term maintenance and access relative to the preliminary design.
- H. All criteria, master plans, and technical information used in support of the preliminary drainage design concept shall be referenced.
- I. All calculations shall be included in organized appendixes at the end of the report. Provide separate appendixes for undeveloped/historic hydrology, developed hydrology, preliminary detention pond sizing, etc...

### **2.1.5 Drainage Plan**

A preliminary drainage plan of the proposed development at a scale of no more than 1 inch equals 200 feet on a standard 24" x 36" sheet shall be included to better identify existing and proposed conditions on or adjacent to the proposed development. Large offsite basins may be delineated on 8 ½ x 11 or 11x 17 sheets and included in the appropriate appendix of the report. The preliminary drainage plan shall include:

- A. Existing contours (2' contour interval minimum), streets, roads, ditches, fence lines, streams, rivers, buildings, trees, utilities, wetlands, etc...
- B. Proposed spot elevations on streets and across lots, or proposed contours.
- C. Proposed streets and lots.
- D. Existing and proposed basin delineation showing basin delineators and basin areas.
- E. Design points at which runoff shall be determined (inlets, culverts, low points, critical intersections, channel confluences, discharge points, etc...).
- F. Location and magnitude of offsite runoff entering the site.
- G. Location and magnitude of runoff leaving the site.
- H. Location of potential detention facility with approximate active volume and release rate.
- I. Approximate location of storm inlets, storm sewers, and drainage swales.
- J. Existing 100-year flood plains.

### **2.2 Final Drainage Report**

The purpose of the final drainage report is to update the concepts and to present the design details for the drainage facilities presented in the preliminary drainage report.

The final drainage report shall be submitted with the final plat application submittal. The drainage report shall be prepared by or under the supervision of a registered professional engineer licensed

in Colorado. The final report shall be properly certified and signed by such Professional Engineer. If the Final Plat is to be presented in sections, filings, or phases, a general drainage plan for the entire development shall be presented with the first section and appropriate development stages for the drainage system for each section shall be indicated. In the event that a development master plan or a preliminary drainage report for an entire development are available, the final report for any portion there of shall include the design of any necessary temporary facilities. The approved final drainage report must be able to function as a stand alone document and show that even the temporary facilities can function adequately in perpetuity.

Where a development is traversed by a water course, drainage way or stream, there shall be provided a perpetual drainage easement conforming substantially with the lines of such watercourse, and of such width as necessary and adequate to carry off the predictable volume of storm water drainage from a one hundred (100) year frequency storm as determined by the Engineer or as determined by a basin master plan.

### **2.2.1 Additional Information**

The final drainage report shall contain all components of the preliminary drainage report plus additional necessary information relating to design of facilities associated with the proposed development. Such additional information shall include the following:

- A. All criteria, master plans, and technical information used for report preparation and design shall be referenced;
- B. A discussion of previous drainage studies (i.e., drainage reports, project master plans) for or adjacent to the proposed development in question that influence or are influenced by the drainage design and how the previous studies will affect drainage design for the site;
- C. A discussion of the proposed drainage interception and conveyance facilities. A description of street capacity calculations, inlet design, storm sewer/culvert designs, swale/channel designs, and riprap design shall be included. The methods of evaluation and assumed design constraints shall be provided;
- D. A discussion of proposed methods to control erosion and/or contain sediments on site. The discussion should include descriptions of proposed structural methods, vegetative methods, temporary facilities, and permanent measures;
- E. There are a multitude of Storm Drainage evaluation programs available. It is not the intent of the Town of Firestone to dictate the methods with which storm drainage is evaluated and designed. The engineer who signs and stamps the Final Drainage Report needs to have a thorough understanding of the program they are using and what the output represents. There are however basic design information that we need to be able to extract from a Drainage Report to complete a review and determine that the results are acceptable to the Town of Firestone. Tables included in the following section (2.2.2 Final Drainage Design Requirements) are examples of what the Town of Firestone will require from a Final Drainage Report. We realize that certain developments and site conditions may require additions or modifications to these tables, and we will deal with these on a case-by-case basis.

## 2.2.2 Final Drainage Design Requirements

- A. Any information pertaining to changes from the preliminary design need to be presented in the final report.
- B. Supporting calculations for identification of design rainfall, runoff calculation method, design storm recurrent intervals, and detention discharge and storage calculation method;
- C. Hydraulic criteria and supporting calculations for the design of streets, swales, channels, inlets, storm sewers, riprap, drop structures, etc...
- D. Tables shall be prepared to summarize the following information:
  1. Historic and Developed runoff at design points. Attenuate as applicable.

BASIN	SUB BASIN	DESIGN POINT	AREA (Ac.)	RUNOFF COEFF. C	CURVE NUMBER CN	PEAK DISCHARGE		
						Q 2-vr (cfs)	Q 10-vr (cfs)	Q 100-vr (cfs)
H	H1	1	10.95	0.20	1.00	1.3	32.9	31.1
	H2	2	18.01	0.20	1.00	1.3	39.0	36.8
	H3	3	2.44	0.25	1.00	1.3	13.5	12.5
OS	OSA	A	5.25	0.25	1.00	1.3	25.6	23.7
	OSB	B	0.19	0.20	1.00	1.3	23.6	22.3
	OSC	C	0.10	0.20	1.00	1.3	22.4	21.1

2. Street capacities for the major and minor storm events.

BASIN	DESIGN POINT	CONTRIBUTING SUBBASINS	STREET SLOPE (%)	CAPACITY REDUCTION FACTOR	ALLOWABLE CAPACITY	ALLOWABLE CAPACITY	PEAK DISCHARGE	PEAK DISCHARGE
					Qa(2-vr) (cfs)	Qa(100-vr) (cfs)	Q(2-vr) (cfs)	Q(100-vr) (cfs)
A	8	A7,A8	0.5	0.65	24.4	24.4	24.4	23.8
	10	A9,A10	0.7	0.80	34.7	34.7	34.7	29.6
	13*	A2,A7,A8,A9,A10,OSG	1.3	0.80	46.7	46.7	46.7	84.5
B	26	B2,B3	0.7	0.80	33.3	33.3	33.3	11.4
	28	B4,B5	0.9	0.80	37.7	37.7	37.7	8.5

3. Inlet design including inlet condition, type, and size.

BASIN	DESIGN POINT	INLET NUMBER	INLET TYPE	CONDITION	PONDING DEPTH (ft)	STREET SLOPE (%)	ALLOWABLE CAPACITY (cfs)	100-vr DESIGN FLOW (cfs)	INTERCEPTED BY INLET (cfs)	PASSED BY INLET (cfs)	ACTUAL INLET LENGTH (ft)
A	8	6A & 6B	TYPE "R"	ON GRADE	N/A	1.5	N/A	28.6	16.8	11.8	15.0
	10	7A & 7B	TYPE "R"	ON GRADE	N/A	1.3	N/A	37.1	22.0	15.1	15.0
	13	8A & 8B	TYPE "R"	SUMP	1.07	N/A	76.5	48.8	48.8	0.0	15.0
B	28	3A & 3B	TYPE "R"	SUMP	0.71	N/A	34.0	19.8	19.8	0.0	10.0
C	33	4A & 4B	TYPE "R"	SUMP	0.71	N/A	34.0	14.6	14.6	0.0	10.0

4. Storm sewer/culvert design.

LINE	FROM (UPSTREAM)	TO (DOWNSTREAM)	DESIGN FLOW (cfs)	PIPE SLOPE (%)	PIPE DIAMETER (in.)	PIPE MATERIAL
ST-1	POND A	ROAD A	26.0	2.0	30	CMP
ST-2	ROAD A	POND A	9.0	2.4	24	RCP
ST-4	INLET 1A	INLET 2A	14.6	1.5	24	RCP
	INLET 2A	MH 2A	48.8	0.5	29x45	ELLIP. RCP
	MH 2A	MH 1A	51.0	0.8	36	RCP
	MH 1A	POND A	69.1	1.0	42	RCP
ST-13	INLET C	IRRIGATION DITCH	11.0	2.5	24	ADS

5. Swale/ditch designs.

LOCATION	DESIGN SLOPE (%)	DESIGN FLOW Q(100-vr) (cfs)	SIDE SLOPE (XH:1V)	BOTTOM WIDTH (ft)	MANNING'S "n"	NORMAL DEPTH (ft)	FREEBOARD (ft)	FLOW VELOCITY (fps)	MISC.
BASIN C - ST-8 OUTLET	0.50	39.20	4.0	0.00	0.035	1.87	2.83	2.8	
BASIN K - DP 24 OUTLET	25.00	18.64	4.0	24.69	0.027	0.05		14.9	Riprap
BASIN M1 - DP 25 OUTLET	0.56	14.06	4.0	0.00	0.035	1.24	1.38	2.3	

## 6. Riprap design.

LOCATION & DESCRIPTION	100-yr DESIGN FLOW (cfs)	100-yr VELOCITY (fps)	PIPE SIZE (in.)	DEPTH AT OUTLET (ft.)	RIPRAP DEPTH (in.)	RIPRAP SIZE	RIPRAP VOLUME (yd^3)
LINE ST-13 OUTLET	11.0	5.9	24	2.0	18.0	CLASS 9	2
LINE ST-14 OUTLET	9.6	3.1	24	2.0	18.0	CLASS 12	2
LINE ST-2 OUTLET	9.0	4.7	24	6.8	18.0	CLASS 9	2

## 7. Detention pond design.

A table shall be prepared that will include all information that is required for the Drainage Plan:

LOCATION & DESCRIPTION	POND CAPACITY (ac-ft)	ACTIVE CAPACITY (ac-ft)	OUTLET ELEVATION (ft)	WATER SURFACE ELEV.		RELEASE RATE	
				10-yr (ft)	100-yr (ft)	10-yr (cfs)	100-yr (cfs)
POND 1	11.0	5.9	4935.00	4940.00	4942.50	10.5	65.3
POND 2	4.3	4.3	4938.50	4941.00	4944.30	16.7	38.5
POND 3	2.5	2.5	4939.25	4942.30	4945.00	4.9	12.6

Well organized technical appendixes shall show calculations for historic and developed hydrology, street capacity calculations, inlet calculations, storm sewer/culvert capacity calculations (including 100-yr hydraulic grade lines), swale/channel capacity calculations, riprap design, and detention volume requirements.

### **2.2.3 Drainage Plan**

A final drainage plan of the proposed development at a scale similar to the overall utility plan in the final plat package shall be included. The drainage plan shall show the following information in addition to the information required on the preliminary drainage plan:

- A. Existing and proposed contours at two (2) feet maximum intervals;
- B. Property lines and easements;
- C. Streets, curb, gutter, and sidewalk and gutter flowline;

- D. Existing drainage facilities and structures, including irrigation ditches, roadside ditches, drainage ways, gutter flow directions, and culverts. All pertinent information such as material, size, shape, slope, and locations shall also be included;
- E. Overall drainage area boundary and drainage sub-area boundaries relating to the proposed development (both historic and developed);
- F. Proposed gutter type (i.e., vertical or drive-over curb and gutter) and cross-pans;
- G. Proposed storm sewer and open drainage ways, including inlets, manholes, culverts, and other appurtenances. Inlets, storm sewers, culverts, and other proposed facilities shall be labeled in a manner consistent with the labeling in the drainage report and the construction plans;
- H. Proposed outfall point and flow for runoff from the developed area and facilities to convey flows to the final outfall point without damage to downstream properties;
- I. Path(s) chosen for computation of time concentration;
- J. Details of detention storage facilities and outlet works, including pond capacity, active capacity, outlet elevation, 100-year/10-year water surface elevation, and 100-year/10-year release rate.
- K. Location and elevation of all defined flood plains affecting the proposed development;
- L. Location of all existing and proposed utilities affected by or affecting the drainage design;
- M. Typical cross sections of open channels, natural drainageways, and roadside ditches showing the 2-year water surface and the 100-year water surface.

## **SECTION 3: HYDROLOGY STANDARDS**

### **3.1 Analytical Methods**

The Engineer is to use published material by a generally accepted authoritative source such as Urban Drainage and Flood Control District, or other publication applicable to the project. The material used must be referenced and applicable parts copied as part of the submittal information. The Rational method and the Colorado Urban Hydrograph Procedure (CUHP) are reliable methods used in the Denver region. Rainfall time intensity frequency (IDF) curves are included with this criteria manual.

#### **3.1.1 Applicability Of Methods**

The Rational method is recommended for overland flow from tributary basins generally less than 200 acres in area. Representation of areas above 200 acres by the Rational method is not recommended, primarily because runoff magnitudes become inaccurate. When the Rational method is used it is important to attenuate runoff at design points. Attenuation should be achieved by applying the highest time of concentration of the contributing sub-basins to the total area contributing to the design point. It is also important to remember to calculate composite

runoff coefficients when attenuating runoff so that an accurate representation of the ground conditions is used. Calculation of composite runoff coefficients and attenuation should be included in the hydrology appendix of the report. Methods such as CUHP, SWMM, and SCS methods are better suited to represent areas larger than 200 acres. SCS methods have been shown to be accurate, particularly for undeveloped ground. SCS methods are not always applicable for developed conditions so the Engineer will be expected to demonstrate that the curve numbers selected do accurately reflect the proposed ground conditions. The hydrologic method selected by the Engineer needs to be reasonable for the undeveloped land use. Undeveloped runoff rates in the Firestone area tend to fall between 0.50 cfs/Ac. and 1.0 cfs/Ac. depending on the basin size and slope. Soils tend to be sandy for most of the Firestone area and it is important to not overestimate the undeveloped runoff rates that will be used for detention pond release rates. Other methods of determining rainfall runoff not mentioned here will be considered by the Town on a case by case basis.

### **3.1.2 Engineering Judgment**

For many new development sites there may be specific constraints (topographic, space allocation, economic etc.) that lead to new innovative methods of draining runoff. In addition certain assumptions are often used within the framework of existing methods of calculating runoff. In both cases engineering judgment must be used. All of the assumptions, underlying principles and sources of information used in a drainage system design must be explained and documented within the final drainage report.

## **3.2 Hydrologic Data Requirements**

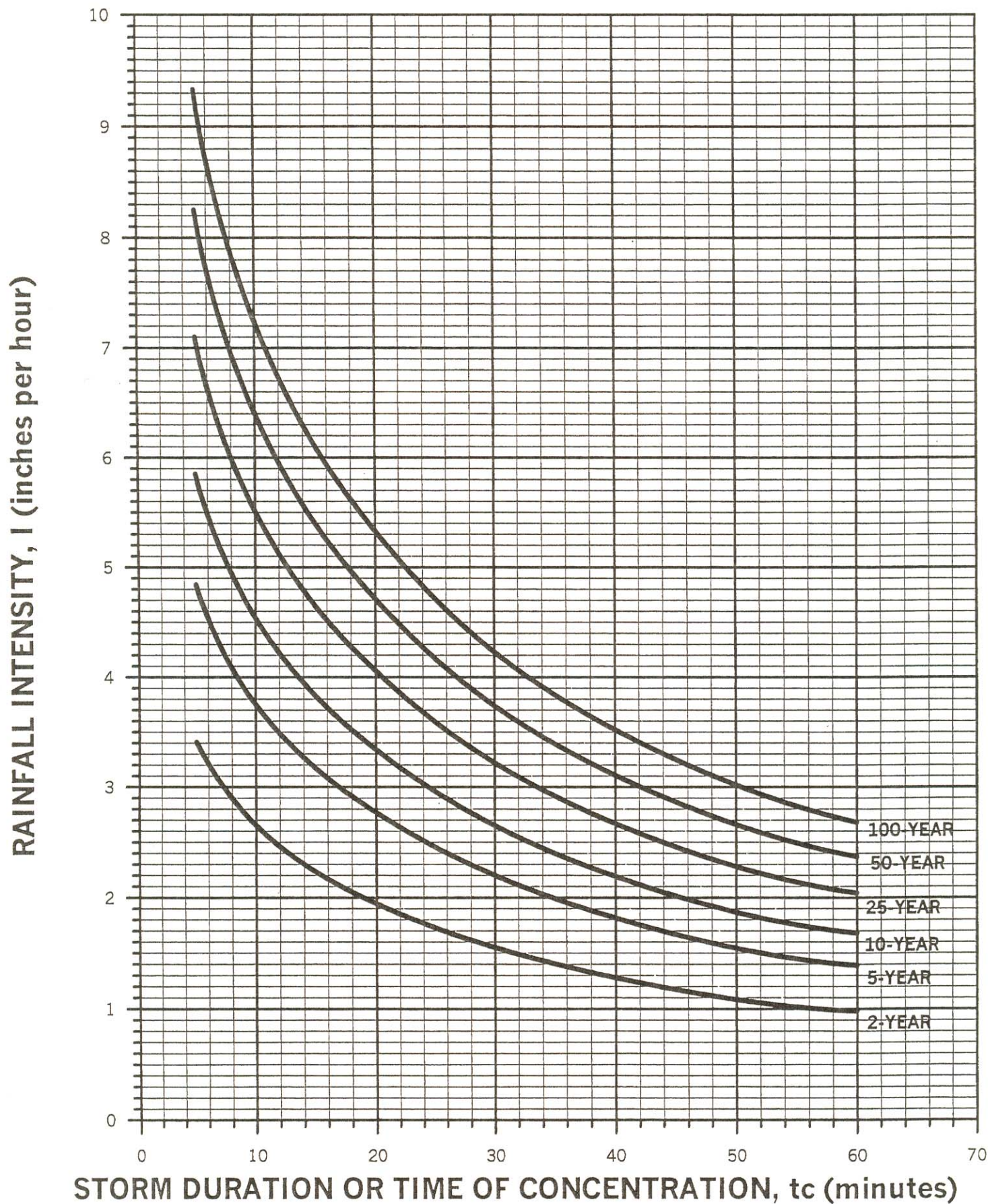
Hydrologic data is the primary information needed to complete a drainage system and report. Regardless of what methodology is used to compute peak runoff, the following requirements apply to all hydrologic data.

### **3.2.1 Rainfall Intensity**

Rainfall data should be current and appropriately selected by geographic region. Rainfall time intensity frequency (IDF) curves for the Firestone area are included on the following page with this criteria manual. IDF curves were determined in the "South Weld I-25 Corridor Master Drainage Plan", by Anderson Consulting Engineers, February 17, 2000. These curves are valid for the Tri-Town Basin and the Godding Hollow Basin. The Engineer shall use appropriate NOAA Rainfall Atlas information, or may use the Depth-Duration-Frequency data included in the Urban Drainage and Flood Control District's design manual, to generate necessary rainfall information.



# TIME - INTENSITY - FREQUENCY CURVES





### **3.2.2 Design Storm**

The storm frequencies to be used in the design of storm sewer/culvert systems, inlet evaluations, and street capacity evaluations shall be obtained from the Design Storm Frequency Table listed below.

<b><u>TABLE OF DESIGN STORM FREQUENCIES</u></b>	
<b><i>Land Use</i></b>	<b><i>Design Storm Period</i></b>
Residential	2 years and 100 years
Open Space	2 years and 100 years
Commercial	2 years and 100 years
Public Buildings	2 years and 100 years
Industrial	2 years and 100 years

### **3.2.3 Offsite Flows**

All offsite flow over and across a proposed development needs to be analyzed on a per basin basis. The runoff for all such basins must be calculated using a method acceptable to the Town of Firestone. All the data calculated must be incorporated into the whole drainage system and the increased runoff onsite accounted for in the final drainage report. If a proposed development is discharging offsite the downstream property must not be adversely affected.

## **SECTION 4: INLETS**

### **4.1 Design**

All storm drainage curb inlets must be CDOT Type 'R'. Storm drainage inlets in sump conditions shall be designed to accept and convey the 100-year storm. In no case shall a 100-year design storm frequency cause inundation above allowable ponding depths to any structure or pose a hazard. Area inlet shall be allowed in the street. Area inlets may be allowed in open space areas and parking lots. The design of any inlet in a sump shall also consider how runoff would overflow in the event of 100% inlet plugging. The site grading should accommodate some passage for flows in excess of the 100-yr event storm or a plugged inlet. Several methods of determining inlet capacity are available to the Engineer. Regardless of the method, the design should include some oversizing to account for partially plugged inlets.

#### **4.1.1 Inlet Operation: Sump & Continuous Grade Conditions**

Two conditions occur when inlets are utilized to drain storm runoff, a sump condition or an on grade (continuous grade) condition. An inlet operating in a sump condition is recommended. On grade inlets operate inefficiently and usually cost more. The use of on grade inlets should be limited to only those cases where providing a sump is not practical. If an on grade inlet needs to be more than ten feet in length the Town may require the design to be modified to create a sump.

#### **4.1.2 Allowable Ponding Depth In Streets**

For the 2-yr event storm, a maximum depth at the gutter flowline of 0.5 feet is allowable. The allowable ponding depth for the 100-yr event is 1.5 feet. For inlets designed to operate in conjunction with a storm sewer system under a surcharged condition the above mentioned allowable depths refer to the combined ponding depth for inlets and the storm sewer surcharge depth. (Example: A particular sump inlet at El= 4950.0 requires 0.65' of ponding depth to accept the 100-yr runoff. The receiving storm sewer is surcharged 0.45' over the inlet flowline. Therefore the actual 100-yr water surface elevation over the inlet is at El=4951.1, 0.40' less than the maximum allowable elevation.) The depth of ponding water occurring at inlets caused by the hydraulic design of storm sewer piping and backwater effects cannot exceed the allowable depths mentioned above.

### **SECTION 5: STORM SEWERS**

#### **5.1 Design**

Storm sewers shall generally be designed to convey 100-yr storm event runoff. Storm sewers shall generally be located in the public Right-of-Way. Storm sewers located outside of the Right-of-Way shall be located in minimum 20 foot exclusive easements granted to the Town of Firestone. Under no circumstances shall a proposed design include installation of trees, shrubs, flower beds, or other landscaping features over storm sewer lines. Likewise, trails shall not be designed over storm sewers (crossings are permitted).

##### **5.1.1 Hydraulic Evaluation**

All storm sewer designs shall include a hydraulic evaluation for each segment of the system. the hydraulic grade line (HGL) shall be calculated and shown on the storm sewer construction plan and profile sheet(s). The hydraulic evaluation shall consider the 100-yr water surface of the downstream receiving body (storm sewer, detention pond, drainage swale, stream, etc...). The design shall not allow a surcharge above any manhole rim. Surcharges at inlets shall be considered when performing inlet design/inlet ponding depth calculations. Several methods of evaluating storm sewers are available to the Engineer. The storm sewer appendix should include all appropriate design assumptions (Q, pipe size/material, slope, length, roughness, downstream hydraulic surface, etc...). Labels of storm inlets, manholes, and reaches shall be consistent with those used on the drainage plan and on the construction plans.

##### **5.1.2 Alignment**

Storm sewer alignment changes (horizontal and vertical) shall only occur at manholes. Storm sewers located in the public Right-of-Way shall only be located under the proposed street asphalt. A minimum clear distance of five feet shall be maintained between the storm sewer and the gutter flowline. Storm sewers shall also maintain a minimum ten feet of horizontal separation with all other utilities. Storm sewers located outside of the Right-of-Way in easements shall be centered in twenty foot minimum width easements. For wider easements, the storm sewer centerline must remain at least ten feet from the edge of the easement. Storm sewers shall never have reverse grades or level spots. Minimum slope of any storm sewer shall be 0.20% although 0.50% should be the target minimum slope and may be required by the

Town if nuisance flows are estimated to be substantial (>1 cfs). Storm sewer joints shall be concrete encased ten feet on either side of any waterline that crosses underneath. A minimum vertical clearance of 18" shall be provided between the storm sewer and any other utility crossing.

## **5.2 Storm Sewer Pipe**

Storm sewers located within the public Right-of-Way, under private streets, or under parking lots shall be reinforced concrete pipe (RCP) of adequate strength class and bury depth. Storm sewers, or portions of storm sewers, located in open space areas may be smooth interior walled high density polyethylene pipe (HDPE). No storm sewer or portion thereof shall be polyvinyl chloride (PVC) pipe. Other pipe materials will be considered by the Town on a case by case basis. All pipe outlets shall include either a headwall or flared end section. Any pipe that is under a surcharge condition shall have appropriate water tight joints. These are to be specified on the storm sewer construction plan and profile sheet(s). The Engineer shall be responsible for ensuring that the pipe joint specified will adequately perform under the design hydraulic condition.

## **5.3 Storm Manholes**

For storm sewer pipe sizes up to and including 24" inside diameter the minimum manhole inside diameter shall be 48" and the manholes shall be spaced no more than 400 feet apart. For storm sewer pipe sizes larger than 24" up to and including 42" inside diameter the minimum manhole inside diameter shall be 60" and the manholes shall be spaced no more than 500 feet apart. Storm sewers larger than 42" inside diameter shall require either 72" inside diameter manholes, rectangular vaults, or vertical offset tees. Spacing of any of these larger structures shall not exceed 750 feet. If elliptical pipe is to be used the horizontal pipe dimension shall be used to determine minimum manhole sizing. Manhole bases may be placed on the same grade as the storm sewer with no additional drop provided. Manhole rims shall generally be set flush with finished ground except that some conditions may warrant they be buried (across farm fields).

# **SECTION 6: STREETS**

## **6.1 Design**

Streets are typically an integral part of the storm drainage system. Conveyance of storm runoff in streets shall be limited to certain depth and encroachment criteria. Consideration shall also be given to the flow characteristics of runoff in streets. For example, the Engineer will need to consider such items as street slopes and the change in flow direction. If a significant amount of runoff is to be conveyed down a long and steep street it is not likely that the runoff will easily be able to turn 90° at a cross street.

### **6.1.1 Drainage At Intersections**

Because of the intersecting grades and congregation of inlets and crosspans etc., intersections are often problematic drainage areas. When a major arterial intersects a local street the grade of the major arterial must be continued through the intersection as much as possible while not interfering with drainage.

### **6.1.2 Allowable Street Capacities**

Minor storm street encroachment for residential streets shall allow no curb topping. Collector and arterial streets shall have at least one lane width open. Major storm street encroachment for residential and collector streets shall allow a maximum flow depth of six (6) inches over the crown. For arterial streets the flow depth at the crown shall not exceed six (6) inches and the gutter flow depth shall not exceed eighteen (18) inches. Allowable street capacities must be calculated and shown in tabular form in the final drainage report.

### **6.1.3 Allowable Cross Street Flow**

If the constraints of a proposed development, from the standpoint of drainage, create a situation where runoff must cross the crown of a street, the following criteria must be met. For minor storm flows across a local or collector street a maximum depth of (6) inches is allowable. No cross street flow is allowable for arterials during a minor storm event. Major storm cross street flows for local and collector streets may have a maximum depth of (18) inches above gutter flowline. The allowable cross street flow across arterials during a major storm is (6) inches or less over the crown. Whenever possible, design of a drainage system shall avoid cross street flows as much as possible. Allowable cross street flows must be shown in tabular form in the final drainage report.

## **SECTION 7: CULVERTS**

### **7.1 Design**

All culverts under major arterials must be designed to convey the 100-yr event. Culverts under local and collector streets must be designed to convey the 10-yr event. These culverts must also be designed with an overflow capacity for the major storm.

#### **7.1.1 Hydraulic Analysis**

All culverts that are part of the proposed drainage system whether inlet or outlet control must be designed so that no damage results during the 100-yr event. The minimum velocity for flow through a culvert shall be 2 ft/s. The minimum effective diameter of any culvert shall be (12) inches. All tailwater and headwater conditions must be designed to be controllable and specific calculations shown in the final drainage report. The hydraulic grade line must be analyzed to ensure that ponding depths (in the case of inlet control) do not inundate structures and adhere to allowable street capacities when applicable. In the case of culverts under outlet control, proper erosion control measures must be applied.

## **SECTION 8: OPEN CHANNELS**

### **8.1 Design**

Open channels should be designed such that the flow is not at critical depth or super critical. Channels must be designed to carry the 100-yr event. Irrigation ditches shall not be used as discharge points for the minor or major storms, except where said discharge is in conformance with an approved master drainage study or variance.

### **8.1.1 Unlined Channels**

Unlined channels should be used when there are no constraints on the hydraulic design, from topography or space limitations. The maximum channel depth of flow shall be 4 feet. The critical depth shall be determined for the major and minor events to ensure that supercritical flow conditions do not occur. The minimum amount of freeboard shall be 1 foot or 1/3 of the design flow. Channel slopes shall be constructed so that flow velocities do not exceed 7.5 ft/s during the major storm or less than 2 ft/s for the minor storm. Unlined channels with longitudinal slopes less than 2% shall have trickle channels.

### **8.1.2 Lined Channels**

If conditions for unlined channels cannot be met, channels shall be lined. If supercritical flow conditions are unavoidable, all concrete channel sections must continuously be reinforced, longitudinally and laterally. A minimum of 1 foot of freeboard or 1/3 of the design flow is required. All lined channels must be protected from uplift forces by drain piping, weep holes or appropriate footings. If a lined channel with a supercritical flow condition discharges into unlined channel, an energy dissipation structure must be constructed at such junction.

### **8.1.3 Channel Section Criteria**

Side slopes for unlined channels can be a maximum of 4:1. When concrete trickle pans are used the minimum width shall be 3 feet, and minimum thickness (6) inches. Overflow swales shall be designed in accordance with Section 8.1.1 of this manual. Freeboard is not required for overflow swales, which are designed only to operate under inlet clogging conditions. Design calculations (in tabular form) must be shown as well as cross-sections in the final drainage report.

## **SECTION 9: DETENTION**

### **9.1 Storage Requirements & Release Rates**

All storm water detention facilities shall be designed to detain the storm water runoff from the fully developed site from a 100-year storm and release the flow at a rate not to exceed to the 100-yr historic rate of runoff at the pond outlet point. In addition, the detention pond outlet structure must detain the 10-yr developed site runoff and release it at the 10-yr historic rate at the pond outlet point. More restrictive release rates may be required by the Town for any given site if it is determined by the Town that the more restrictive rate is in the best interests of the public. Active storage capacities, 10-yr and 100-yr release rates, and 10-yr and 100-yr water surface elevations must be shown on the drainage plan for all proposed detention ponds onsite.

#### **9.1.1 Outlet Structures**

Outlet structures must be designed to release detained runoff at the 100-yr historic rate. Outlet structures must also take into account low flow or “nuisance flow” conditions. Such conditions can create maintenance hazards and property damage. A minimum of 1 foot of freeboard is required above the 100-yr water surface elevation.

## **SECTION 10: FLOODPLAIN ISSUES**

### **10.1 Town Jurisdiction**

If a development or portion of a proposed development is located in a flood hazard area, all applicable regulations of the Town shall be met. All federal and state regulations shall also be met prior to the regulations of the Town. All applicable information must be shown on the final drainage plan regarding existing and proposed (if applicable) flood areas.

#### **10.1.2 Storm Drainage And Floodplains**

Drainage areas shall be left in a natural state unless approved by the Town and no encroachment shall be made on the natural channel. A plan to prevent water pollution shall be submitted and adhered to wherever any modification of topography is required during construction.

## **SECTION 11: EROSION CONTROL**

### **11.1 Requirements**

Erosion control measures must be addressed for potential erosion caused by runoff, drainage system discharge or wind. Proposed locations where erosion control structures are constructed must be shown on an erosion control plan (which can be shown on the grading plan). In addition the size, type and dimension of all rip rap pads must be labeled.

## **SECTION 01070**

### ***ABBREVIATIONS***

#### **PART 1 - GENERAL**

Wherever used in these specifications the following abbreviations shall have the meanings indicated:

<i>AASHTO</i>	American Association of State Highway & Transportation Officials
<i>ADS</i>	Advanced Drainage Systems Pipe
<i>AISC</i>	American Institute of Steel Construction
<i>ISI</i>	American Iron and Steel Institute
<i>ANSI</i>	American National Standards Institute
<i>ASTM</i>	American Society for Testing and Materials
<i>AWS</i>	American Welding Society
<i>AWWA</i>	American Water Works Association
<i>CFS</i>	Cubic Feet per Second
<i>CRSI</i>	Concrete Reinforcing Steel Institute
<i>MSL</i>	Mean Sea Level
<i>PVC</i>	Poly Vinyl Chloride Pipe
<i>RCP</i>	Reinforced Concrete Pipe
<i>UBC</i>	Uniform Building Code

END OF SECTION

## **SECTION 02271**

### ***RIPRAP***

#### **PART 1 – GENERAL**

##### **1.1 Description**

- A. This section covers the construction of riprap on earth slopes, within channel drop structures and at culvert outfalls at the locations indicated on the Drawings and as specified herein.

##### **1.2 Quality Assurance**

- A. Stone shall be hard, durable, angular in shape, and free from cracks, overburden, shale and organic matter.
- B. Stone shall be capable of passing specific gravity, soundness and abrasion tests in accordance with the Urban Drainage and Flood Control District's (DRCOG) "Drainage Criteria Manual," as follows:

<b>TEST DESIGNATION REQUIREMENTS</b>	
Specific Gravity (Saturated Surface - Dry Basis)	10 greater than 2.20
Soundness (Sodium Sulfate Method)	19 less than 6 percent
Abrasion (Using Los Angeles Machine Grading A)	21 less than 6 percent of weight after 500 revolutions

#### **PART 2 - PRODUCTS**

##### **2.1 Riprap Materials**

- A. Stone: gray rhyolite or approved equal.
- B. Quality:
1. Sound, durable, hard, resistant to abrasion and free from lamination, weak cleavage planes, and undesirable effects of weathering.
  2. Rounded stone not acceptable.
  3. Do not use flat or elongated shapes with thickness less than 1/3 the length.



C. The size requirements for riprap gradations are as follows:

<b>CLASSIFICATION &amp; GRADATION OF ORDINARY RIPRAP</b>			
<b><i>Riprap Designation</i></b>	<b><i>% Smaller than Given Size by Weight</i></b>	<b><i>Intermediate Rock Dimension (Inches)</i></b>	<b><i>d<sub>50</sub>* (Inches)</i></b>
Type VL	70-100 50-70 35-50 2-10	12 9 6 2	6**
Type L	70-100 50-70 35-50 2-10	15 12 9 3	9**
Type M	70-100 50-70 35-50 2-10	21 18 12 4	12
Type H	100 50-70 35-50 2-10	30 24 18 6	18
Type VH	100 50-70 35-50 2-10	42 33 24 9	24

\* d<sub>50</sub> = mean particle size

\*\* Bury types VL and L with native topsoil and revegetate to protect from vandalism.

1. Size of stone, length, and total thickness of riprap shall be as noted on the drawings.

- D. All riprap shall be placed on a minimum 4" thick layer of bedding material, which meets one of the following gradations:

<b><u>GRADATION FOR BEDDING MATERIAL</u></b>		
% by Weight passing Square Mesh Sieves		
<b>Sieve Size</b>	<b>Type I (CDOH concrete sand specification (AASHTO M6) Section 703.01</b>	<b>Type II (CDOH Class A, Section 703.09)</b>
3"	-	90-100
1½"	-	-
¾"	-	20-90
"	100	-
#4	95-100	0-20
#16	45-80	-
#50	10-30	-
#100	2-10	-
#200	0-2	0-3

## **PART 3 - EXECUTION**

### **3.1 Preparation**

- A. Shape and compact slopes and channel bed prior to placement of riprap and bedding.

### **3.2 Riprap Placement**

- A. Place in a manner to provide a solid mass of rock within the limits shown on the drawings.
1. Fill spaces between larger stones with smaller stone of suitable size, so placed as to conform to the slope required.
- B. Material may be machine-placed with sufficient hand work to accomplish requirements of this Section. However, bulldozing of stone from the upper banks will not be permitted.
- C. Material shall be placed in a manner such that filter blanket (if used) is not torn or ripped loose from staples. Minimal disturbance of bedding material layer shall be allowed.
- D. Grouted riprap shall be used when conditions warrant. All grouted riprap blankets shall have adequate weed holes provided.

### **3.3 Thickness Tolerance**

A. Plus or minus 10%.

END OF SECTION

## **SECTION 02601**

### ***MANHOLES***

#### **PART 1 - GENERAL**

##### **1.1 Description**

- A. This section covers manholes, including ring and covers, steps, grade rings, fittings, and other appurtenances.

##### **1.2 Quality Assurance**

- A. Manhole inverts shall not deviate from elevations shown on the Drawings by more than (±) 0.03 ft.

##### **1.3 Product Delivery, Storage and Handling**

- A. Do not deliver precast concrete sections to job until concrete has attained at least 80 percent of specified strength.

##### **1.4 Alternatives**

- A. Manhole bases may be either monolithically precast or cast-in-place.

#### **PART 2 - PRODUCTS**

##### **2.1 Concrete**

- A. Cast-in-Place:
  - 1. Meet the Requirements of Section 3300 - Cast-in-Place Concrete (Appendix V).
  - 2. Strength: 3500 psi at 28 days.
  - 3. Cement: Type II.
- B. Mortar:
  - 1. One part Portland Cement, ASTM C150, Type II.
  - 2. Three parts sand, ASTM C144.
  - 3. ½ part hydrated lime, ASTM C207, Type S.
- C. Grout (Non-Shrink):
  - 1. Pre-mixed: Master Builders "Masterflow 713," Sonneborn "Ferrolith G-D.S. Redi-Mixed," or equal.

2. Job Mixed:
  - a. One part Portland Cement, ASTM C150, Type II.
  - b. One part sand, ASTM C144.
  - c. One part shrinkage correcting aggregate, Master Builders "Embco Aggregate," "Sonneborn "Ferrolith G-D.S.," or equal.

## **2.2 Pre-cast Concrete**

- A. Bases, Barrels, Cones and Flat Tops:
  1. Cast base and first barrel section monolithic.
  2. Meet Requirements of: ASTM C478.
  3. Cement: Type II.
  4. Invert: Cast-in-place concrete as specified in paragraph 2.1.A above.
  5. Provide horseshoe shaped openings for manholes to be installed in existing lines.

## **2.3 Manhole Gaskets**

- A. Meet Requirements of: F.S. SS-S-00210, Type I, Rope Form.
- B. Diameter:
  1. 48 inch manholes: 1½ inch.
  2. 60 inch manholes: 1 ¾ inch.
  3. 72 inch manholes: 2 inch.
- C. Approved Manufacturers:
  1. K.T. Snyder Co., "Ram-Nek" or "Rubr'-Nek."
  2. Hamilton-Kent Mfg. Co., "Kent Seal."
  3. Or approved equal.

## **2.4 Pipe Penetration Gaskets**

- A. Approved Manufacturers:
  1. Dukor Co., Ko-N-Seal.
  2. Press Seal Gasket Corp., PS-10.
  3. A-lok Corp., A-lok.
  4. Interpace Corp., Lock joint flexible manholes sleeve.
  5. Or approved equal.

## **2.5 Ring and Cover**

- A. Material: Gray Iron meeting requirements of ASTM A48.

B. Construction:

1. Size: Min. Clear opening 24-inch diameter.
2. Weight: Heavy-duty 400 pounds minimum.
3. Bearing surfaces: machined.
4. Lid pattern: checkered top or indented top.
5. Pick hole: concealed.

**2.6 Steps**

A. Materials: Polypropylene plastic coated steel.

B. Construction:

1. Reinforcing rod: ½ inch dia.
2. Length: 10 inches, designed for 6-inch protrusion from manhole wall.
3. Width: 12 inches.
4. Tread: notched ridge with retainer lugs on each end.

**PART 3 - EXECUTION**

**3.1 Inspection**

- A. Examine each pre-cast section, ring and cover and appurtenance for cracks and other defects. Remove all defective materials from the site.

**3.2 Manhole Size**

- A. Unless otherwise directed by the Town, use the following manhole diameters in conjunction with the appropriate line sizes:

Pipe Size (in)	MH Diameter (in)
≤ 24"	48"
24" – 48"	60"
≥ 42"	72"

- B. Use eccentric cones where manhole depth is 60 inches or greater on 48 inch manholes and 72 inches or greater on 60 inch manholes. Use flat top manholes when manhole depth is less than the above and on all 72 inch manholes.

**3.3 Installation of Pre-cast Manhole Sections**

- A. Connect all pipes to pre-cast manhole sections using pipe penetration gaskets.
- B. If inverts are not constructed by pre-caster and wherever grade and alignment permit, lay

the main sewer continuously through the manhole and split the pipe after construction of the invert. Where this is not possible, terminate pipe flush with interior manhole wall and construct transition smooth and of proper radius for uninterrupted flow. In no case shall the invert flow section through the manhole be greater than that of the outgoing pipe. Finish invert with a steel trowel prior to adding riser section to the base.

- C. Set each manhole riser section plumb. Use sections of various heights to bring ring and cover to grade. Join manhole sections using mortar or pre-formed flexible plastic gaskets. The last barrel section prior to placement of the eccentric cone or the flat top slab shall be the manufacturer's shortest, but in no case greater than 24 inches in height. All joint surfaces shall be clean, dry and warm during installation. Where mortar joints are used, set each section in a one inch minimum full bed of mortar. If flexible gaskets are used, prime entire joint on both barrel sections prior to placement of gasket material.
- D. Install ring and covers on one or a maximum of two pre-cast adjusting rings of varying heights, not to exceed 8 inches in height each. On buried manholes the total allowable height of adjusting rings and the ring and cover shall be one inch less than the manufacturer's shortest pre-cast barrel section. Set rings in a full bed of mortar and encase in mortar around the entire perimeter. Unless otherwise indicated, set the top of the rings 24 inches below finished grade in farmed fields, 6 inches below finish grade in gravel roadways and such that no part of the ring or cover will project above a point  $\frac{1}{4}$  inch below the finish surface of pavement in paved areas subject to cleaning by snowplows.
- E. Fill all lifting holes and other imperfections with mortar. Neatly point inside of joints no matter what joint material is used.

### **3.4 Construction of Cast-in-Place Bases**

- A. Set stubs and mains before concrete is placed and recheck for alignment and grade before concrete has set. Where grade and alignment permit, lay the main sewer continuously through manholes and split the pipe after construction of the base. Where this is not possible, terminate the pipe flush with the interior manhole wall and construct transitions smooth and of proper radius for uninterrupted flow. In no case shall the invert flow section be larger than that of the outgoing pipe. Shape the base with a wood float and finish with a steel trowel. Allow the base to set a minimum of 24 hours before continuing construction.
- B. When thermoplastic pipe is used, connections to the manhole base shall be made using approved manhole couplings cast into the base or a minimum of three pipe gaskets spaced two inches apart on the end of each pipe and cast into the base.
- C. If the pipe connection is to a pre-cast section, use pipe penetration gaskets as specified above.
- D. Install pre-cast manholes risers, cones, and tops and the ring and covers as specified in paragraphs 3.2. C through 3.2.E above.

### **3.5 Field Quality Control**

- A. Inspect each manhole for and repair all visible leaks and damp spots.

## **SECTION 02612**

### ***REINFORCED CONCRETE PIPE***

#### **PART 1 - GENERAL**

##### **1.1 Description**

- A. This section covers reinforced concrete culvert, storm drain and sewer pipe with O-ring rubber gasketed joints. Furnish pipe complete with all jointing materials and other necessary appurtenances.

##### **1.2 Quality Assurance**

- A. Source quality control:
1. Acceptance of pipe shall be based on the results of the manufacturer's material tests and inspection of pipe for defects and imperfections.
  2. Conduct crushing tests on a minimum of two cores or four cylinders from each day's production and every time the concrete mix is changed.
  3. Conduct absorption tests on cores taken from the first three lengths of pipe produced of each size and class and thereafter from one percent of the pipe produced.

##### **1.3 Product Delivery, Storage And Handling**

- A. Do not bump or drop pipe and fittings during handling.
- B. Do not drag the spigot ring on the ground or allow it to come in contact with gravel, crushed stone, rocks or other hard objects.
- C. Do not permit hooks to come in contact with joint surfaces.
- D. Ship rubber gaskets in cartons and store in a clean area away from grease, oil, ozone producing electric motors, excessive heat, and the direct rays of the sun.

#### **PART 2 - PRODUCTS**

##### **2.1 Pipe and Fittings**

- A. Conformance: ASTM C76.
- B. Strength class: as required by conditions.
- C. Cement: Type II.



## **2.2 Joints**

- A. Type: ASTM C443, Rubber Gasket.
- B. Gasket material: Neoprene or other synthetic rubber.
- C. Mortar or sealant will be acceptable in lieu of gasketed joints when hydraulic considerations permit.

## **PART 3 - EXECUTION**

### **3.1 Description**

- A. Examine pipe upon delivery and do not use individual sections with any defect including the following:
  - 1. Fractures or cracks passing through the wall.
  - 2. Defects that indicate imperfect proportioning, mixing, and molding.
  - 3. Surface defects indicating honey-combed or open texture.
  - 4. Damaged or cracked ends where such damage would prevent making a satisfactory joint.
  - 5. Any continuous crack having a surface width of 0.01 in. or more extending for a length of 12 in. or more regardless of position in pipe wall.
- B. Mark rejected pipe with a yellow crayon and remove from the site.
- C. Examine gaskets prior to installation and do not use gaskets which show surface checking, weathering, or other signs of deterioration.

### **3.2 Installation**

- A. Install pipe in accordance with the requirements of the Section 02221 of Appendix V.
- B. Jointing pipe:
  - 1. Joint pipe in accordance with manufacturer's recommendations.
  - 2. Wipe mating surfaces clean and keep foreign materials from interfering with proper joint assembly.
  - 3. Apply lubricant recommended by the pipe manufacturer to the mating surface and the gasket.
  - 4. Position the gasket on the spigot and complete the joint.
  - 5. Check the position of the gasket with a feeler gage after the joint is completed and the pipe is in position.
  - 6. Paint the interior joint space on all pipe 24 inches in diameter and larger with Portland Cement mortar after the pipe is in place.

END OF SECTION

## **SECTION 02623**

### ***CORRUGATED POLYETHYLENE PIPE***

#### **PART 1 – GENERAL**

##### **1.1 Description**

- A. This section covers smooth interior, corrugated polyethylene storm sewer pipe and fittings to be furnished complete with all jointing materials.
- B. Polyethylene pipe shall not be used within street right-of-ways.

##### **1.2 Product Delivery, Storage, and Handling**

- A. Do not damage the pipe by impact, bending, compression, or abrasion during handling and storage.
- B. Store pipe on a flat surface, which provides even support for the barrel.
- C. Do not stack pipe higher than the manufacturer's recommended height.
- D. Ship rubber gaskets in cartons and store in a clean area away from grease, oil, ozone-producing electric motors, heat, and the direct rays of the sun.
- E. Do not use hooks, bare cables, or other devices that may damage the pipe when handling.

#### **PART 2 - PRODUCTS**

##### **2.1 Polyethylene (PE) Storm Sewer Pipe**

- A. Conform to the following standards:
  - 1. All pipe shall have exterior corrugations and smooth wall interiors. Exterior corrugations may be either annular or helical.
  - 2. All pipe and fittings shall be made of virgin PE compounds which meet or exceed ASTM D1248 Type III, Category 4, Grade P33, Class C requirements.

##### **2.2 Non-Pressure Joints**

- A. Non-pressure joints may be used only when the hydraulic grade line is within the inside diameter of the pipe.
- B. The fitting shall be secure enough to withstand stresses from handling and backfilling without failing.
- C. The joint shall be sealed sufficiently to prevent infiltration of ground water and/or silt.

### **2.3 Pressure Joints**

- A. When hydraulic conditions within the pipe produce an internal pressure on the full diameter of the inside of the pipe, a pressure joint shall be used.
- B. The joint shall have a pressure rating at least equal to the internal pressure of the pipe during the major storm, or worst case, event.
- C. The joint shall be sealed sufficiently to prevent "jetting" or leaking at the joint.

### **2.4 Joints to Other Pipe Materials**

- A. PE pipe shall not be jointed to other pipe materials. Connections to other pipe materials shall be done only at manholes, inlets, or other accessible facility.

## **PART 3 - EXECUTION**

### **3.1 Inspection**

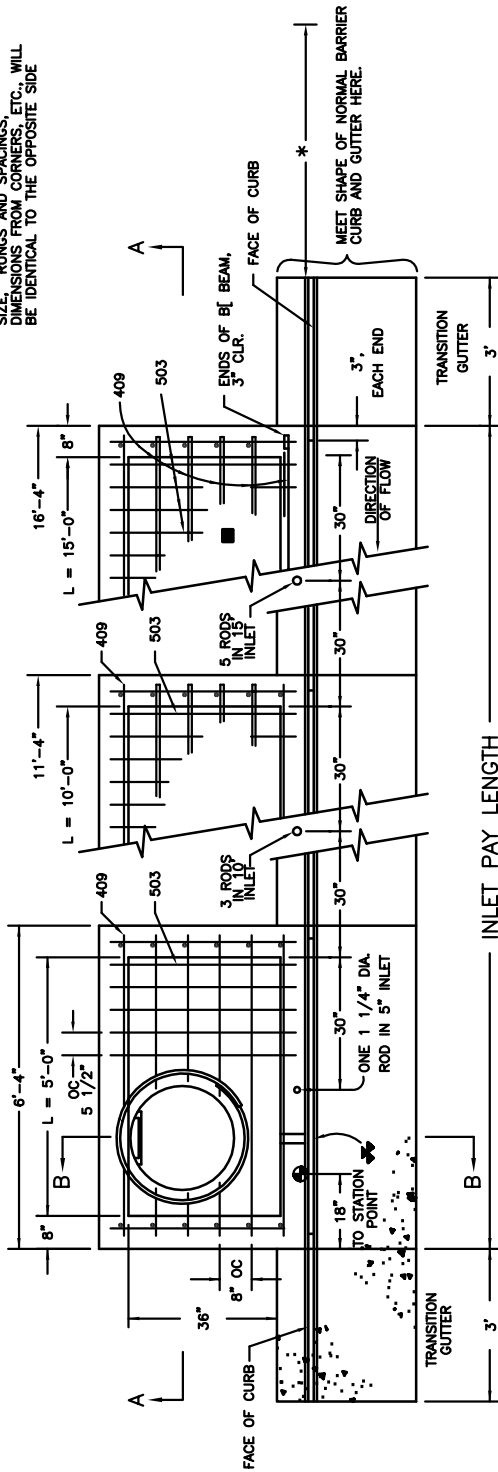
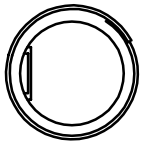
- A. Examine pipe and fittings and do not use individual sections containing:
  - 1. Cracks.
  - 2. Dents.
  - 3. Abrasions.
  - 4. Other defects.
- B. Mark rejected pipe and remove from site.

### **3.2 Installation**

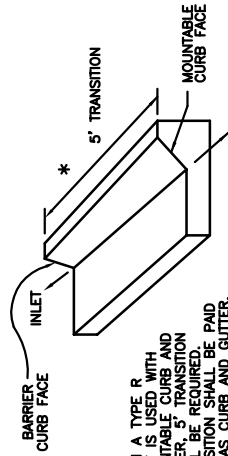
- A. Install pipe in accordance with Section 02221 of Appendix V.
- B. Jointing the pipe:
  - 1. The various manufacturers of PE pipe have differing methods of jointing the pipe that depends on pressure condition and pipe diameter. For this reason, the Contractor is to joint the pipe per the manufacturers recommendations to satisfy the conditions of paragraphs 2.2 and 2.3 of this section.

END OF SECTION

AN ADDITIONAL ACCESS WILL BE REQUIRED FOR INLET SIZES 10" AND LARGER. ALL CONSTRUCTION FOR INLET TYPE AND SIZE, RUNS, AND SPACINGS, ETC., WILL BE IDENTICAL TO THE OPPOSITE SIDE

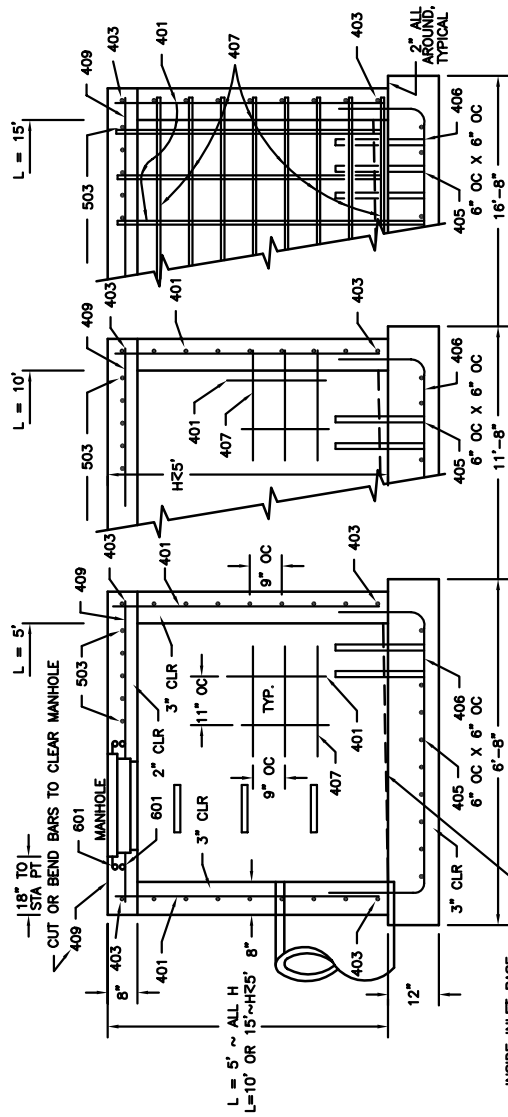


TYPICAL PLAN VIEW



\* WHEN A TYPE R INLET IS USED WITH MOUNTABLE CURB AND GUTTER, 5\"/>

TRANSITION CURB



SECTION A-A  
REGULAR INLET

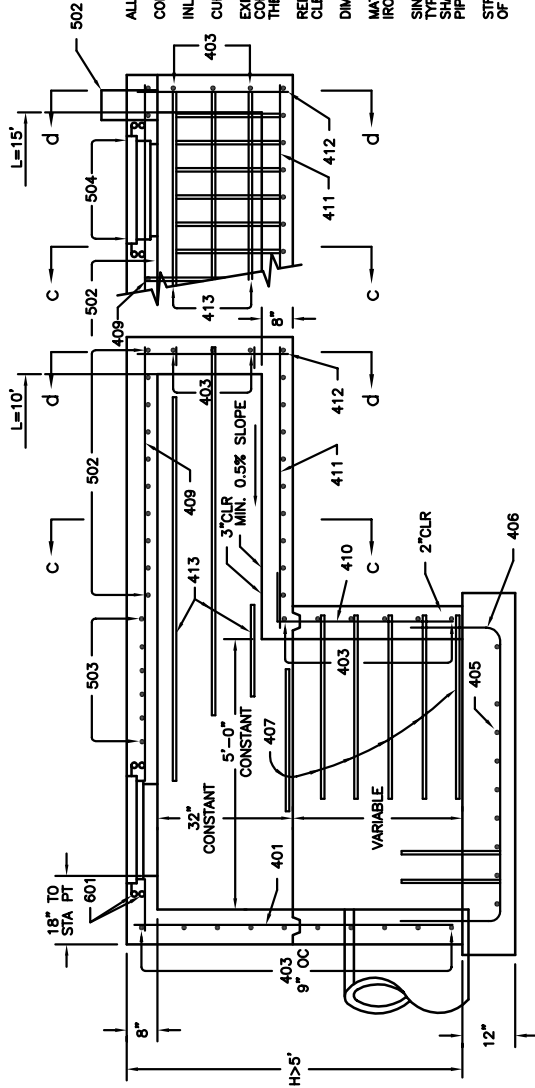
TOWN OF  
FIRESTONE

TYPE 'R' INLET  
DETAIL NO.1

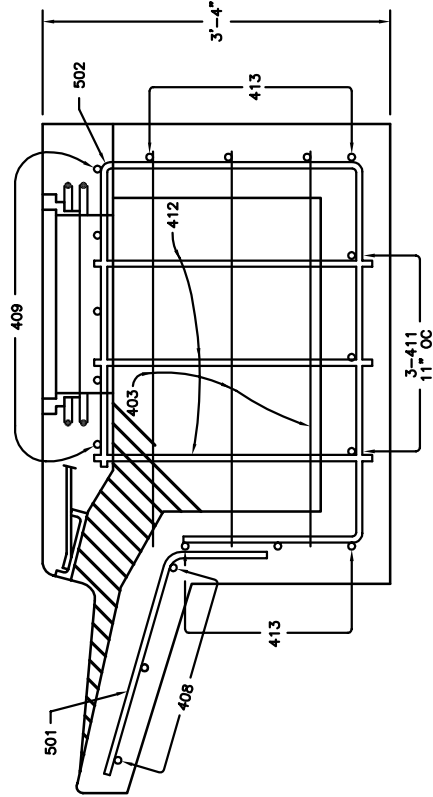
APPROVED BY: MAYOR

TST





SECTION A-A  
INLET WITH DROP BOX ~H>5'

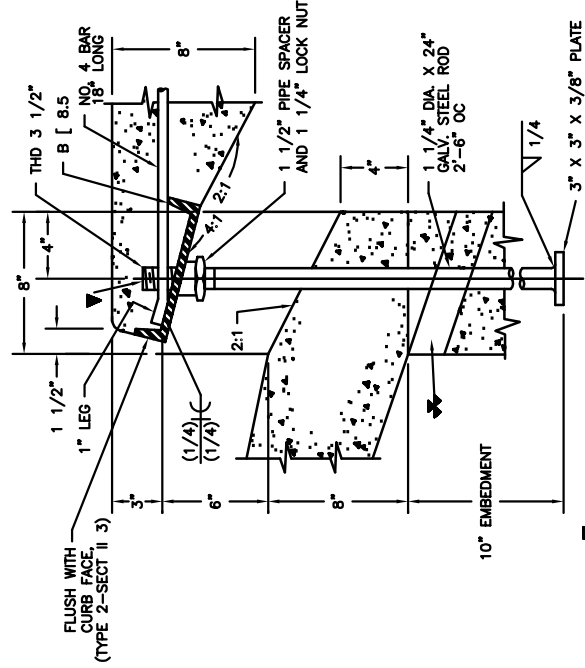


SECTION c-c & d-d  
(DOTTED BARS ARE IN SECTION d-d)

GENERAL NOTES

- ALL CONCRETE SHALL BE CLASS A OR B.
- CONCRETE WALLS SHALL BE FORMED ON BOTH SIDES AND SHALL BE 8" THICK.
- INLET STEPS SHALL BE IN ACCORDANCE WITH ASHTO M 199.
- CURB FACE ASSEMBLY SHALL BE GALVANIZED AFTER WELDING.
- EXPOSED CONCRETE CORNERS SHALL BE CHAMFERED 3/4" CURB AND GUTTER CORNERS SHALL BE FINISHED TO MATCH THE EXISTING CURB AND GUTTER BEYOND THE TRANSITION GUTTER.
- REINFORCING BARS SHALL BE DEFORMED AND SHALL HAVE A 2" MINIMUM CLEARANCE.
- DIMENSIONS AND WEIGHTS OF TYPICAL MANHOLE RING AND COVER ARE NOMINAL.
- MATERIAL FOR MANHOLE RINGS AND COVERS SHALL BE GRAY OR DUCTILE CAST IRON CONFORMING TO 712.06.
- SINCE PIPE ENTRIES INTO THE INLET ARE VARIABLE, THE DIMENSIONS SHOWN ARE TYPICAL. ACTUAL DIMENSIONS AND QUANTITIES FOR CONCRETE AND REINFORCEMENT SHALL BE AS REQUIRED IN THE WORK. QUANTITIES INCLUDE VOLUMES OCCUPIED BY PIPES.
- STRUCTURAL STEEL SHALL BE GALVANIZED AND SHALL CONFORM TO THE REQUIREMENTS OF 712.06.

SEE CHANNEL LAYOUT ON SHEET 2.



CURB FACE ASSEMBLY,  
PLACE ENTIRE ASSEMBLY BEFORE  
POURING CONCRETE

TABLE ONE ~ BAR LIST FOR CURB INLETS, TYPE 'R'

MARK	DIA IN	O.C. SPACING	TYPE	ALL INLETS L = 5'			INLETS, H ≥ 5'			INLETS, H > 5'		
				NO REQ'D LENGTH	NO REQ'D LENGTH	NO REQ'D LENGTH	10'	15'	15'	10'	15'	15'
401	11"	11"	II	15	*	21	*	26	*	11	*	11
402	11"	11"	II	7	*	13	*	18	*	7	*	7
403	9"	9"	II	*	4'-0"	*	4'-0"	*	4'-0"	*	4'-0"	*
405	6"	6"	VI	11	6'-10"	21	6'-10"	31	6'-10"	11	6'-10"	11
406	6"	6"	VIII	7	8'-10"	7	13'-10"	7	18'-10"	7	8'-10"	7
407	1/2"	9"	II	*	5'-10"	*	10'-10"	*	15'-10"	*	5'-10"	*
408	12"	12"	II	3	6'-0"	3	11'-10"	3	16'-0"	3	16'-0"	3
409	8"	8"	II	6	5'-10"	6	10'-10"	6	15'-10"	6	15'-10"	6
410	11"	11"	VII							3	*	3
411	11"	11"	II							3	5'-2"	3
412	11"	11"	II							3	2'-9"	3
413	9"	9"	II							7	10'-10"	7
501	5/8"	5 1/2"	IV	11	3'-4"	22	3'-4"	33	3'-4"	22	3'-4"	33
502	5 1/2"	5 1/2"	III							11	11'-5"	17
503	5 1/2"	5 1/2"	II	5	3'-6"	16	3'-6"	27	3'-6"	6	3'-6"	6
504	5 1/2"	5 1/2"	IX									5
601	3/4"	2 1/2"	V	2	8'-10"	2	8'-10"	2	8'-10"	2	8'-10"	4
601	8.5			1	5'-10"	1	10'-10"	1	15'-10"	1	10'-10"	1
				2 BWS, 1 ROD			4 BWS, 3 RODS		8 BWS, 5 RODS		4 BWS, 3 RODS	
												8 BWS, 5 RODS

\* VARIABLE, REFER TO TABLE TWO.  
 \* INCLUDE 18" NO. 4 BARS (SEE CHANNEL DETAIL).  
 \* SEE CURB FACE ASSEMBLY ON SHEET 1 AND CHANNEL LAYOUT DETAILS ON THIS SHEET.

CHANNEL LAYOUT DETAILS

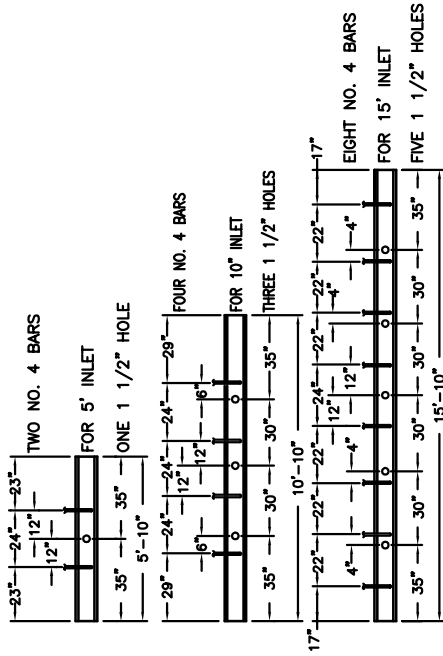
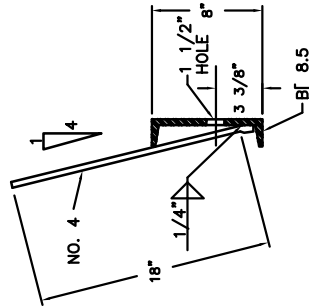


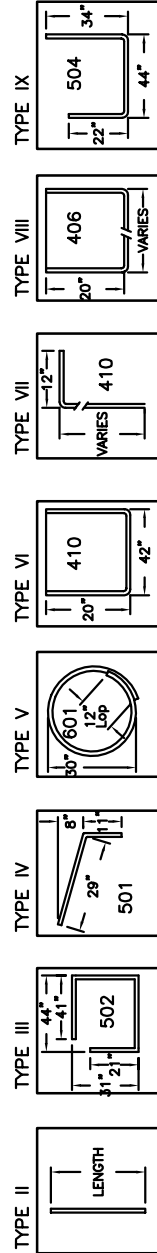
TABLE TWO ~ BARS AND QUANTITIES VARIABLE WITH 'H'

"H"	LENGTH	NO REQ'D		L = 5'		L = 10'		L = 15'	
		REGULAR	DROP BOX	CU YO CONC LB STEEL	CU YO CONC LB STEEL	CU YO CONC LB STEEL	CU YO CONC LB STEEL	CU YO CONC LB STEEL	CU YO CONC LB STEEL
3'-0"	2'-8" 1'-8"	10	7	3.2	285	5.3	497	7.4	706
3'-0"	3'-2" 2'-2"	10	7	3.4	305	5.7	528	7.9	747
4'-0"	3'-8" 2'-8"	12	9	3.7	326	6.0	559	8.4	786
4'-6"	4'-2" 3'-2"	12	9	3.9	334	6.4	571	8.8	803
5'-0"	4'-8" 3'-8"	14	11	4.1	354	6.7	602	9.3	844
5'-6"	5'-2" 4'-2"	16	13	4.4	375	7.0	607	7.4	850
6'-0"	5'-8" 4'-8"	16	13	4.6	382	7.2	616	7.6	860
6'-6"	6'-2" 5'-2"	18	15	4.8	402	7.6	637	7.8	880
7'-0"	6'-8" 5'-8"	20	17	5.0	423	8.0	654	8.0	897
7'-6"	7'-2" 6'-2"	20	17	5.3	430	8.3	664	8.3	907
8'-0"	7'-8" 6'-8"	22	19	5.5	451	8.5	684	8.5	927
8'-6"	8'-2" 7'-2"	24	21	5.7	471	8.7	702	8.7	944
9'-0"	8'-8" 7'-8"	24	21	6.0	479	7.6	711	9.0	954
9'-6"	9'-2" 8'-2"	26	23	6.2	499	7.8	732	9.2	974
10'-0"	9'-8" 8'-8"	28	25	6.4	520	8.0	749	9.4	992
10'-6"	10'-2" 9'-2"	28	25	6.7	527	8.3	759	9.7	1001
11'-0"	10'-8" 9'-8"	30	27	6.9	547	8.5	779	9.9	1022

NOTE: FOR L=5', L=10' AND L=15'.  
 REGULAR INLETS: TOTAL QUANTITIES  
 NEEDED ARE OUTSIDE OF  
 THE HEAVY BLACK LINE.  
 DROP BOX INLETS: TOTAL QUANTITIES  
 NEEDED ARE INSIDE OF THE  
 HEAVY BLACK LINE.  
 STEEL WEIGHTS DO NOT  
 INCLUDE STRUCTURAL STEEL.

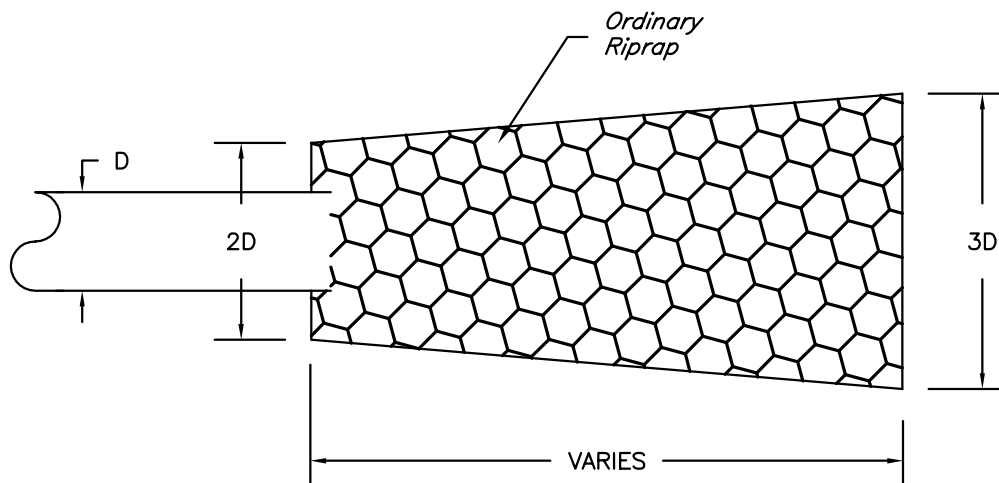


TYPICAL SECTION  
AT HOLE

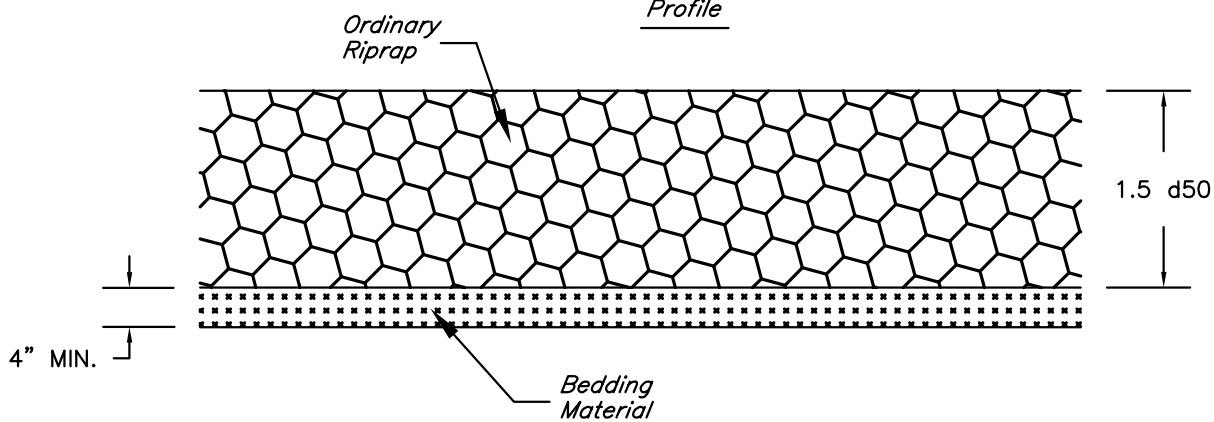


BAR BENDING DIAGRAMS - (DIMENSIONS ARE OUT-TO-OUT OF BAR).

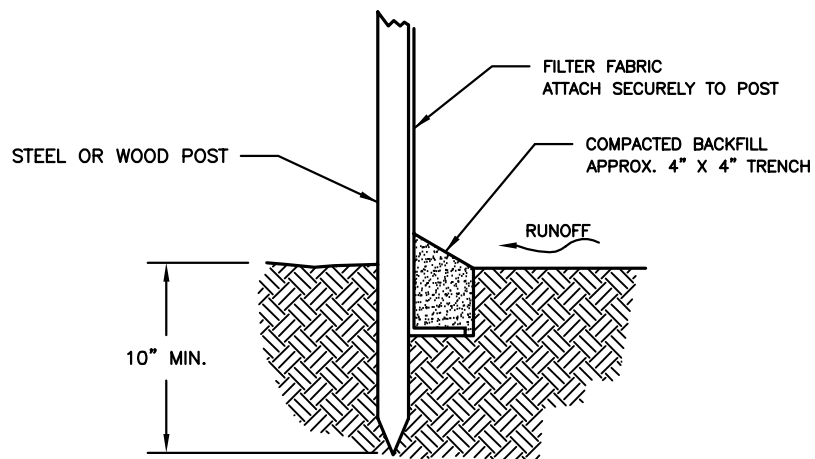
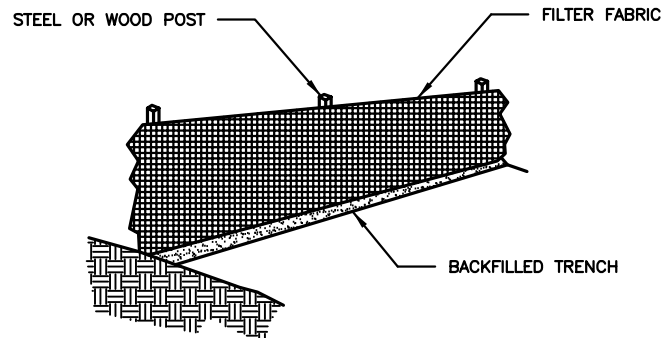
Plan View



Profile







SECTION VIEW

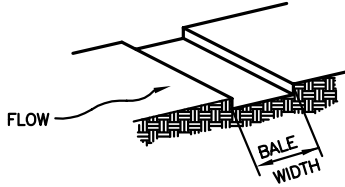
*TOWN OF  
FIRESTONE*

*SILT FENCE DETAIL*

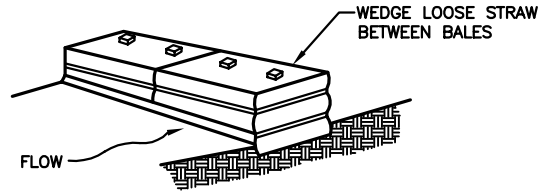
APPROVED BY: MAYOR

**TST**

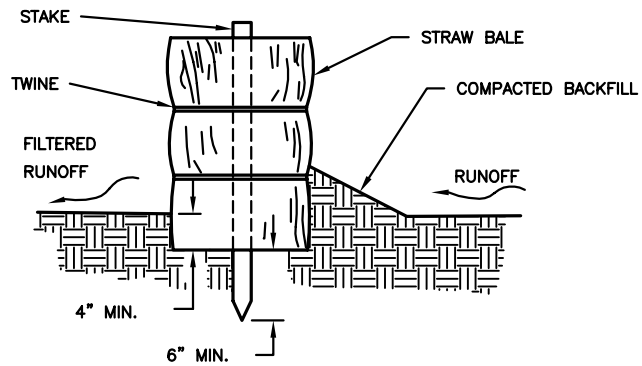
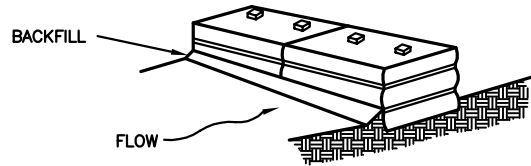
1. EXCAVATE TRENCH,  
4" MINIMUM DEPTH.



2. PLACE AND STAKE  
STRAW BALES.



3. BACKFILL COMPACT EXCAVATED SOIL.



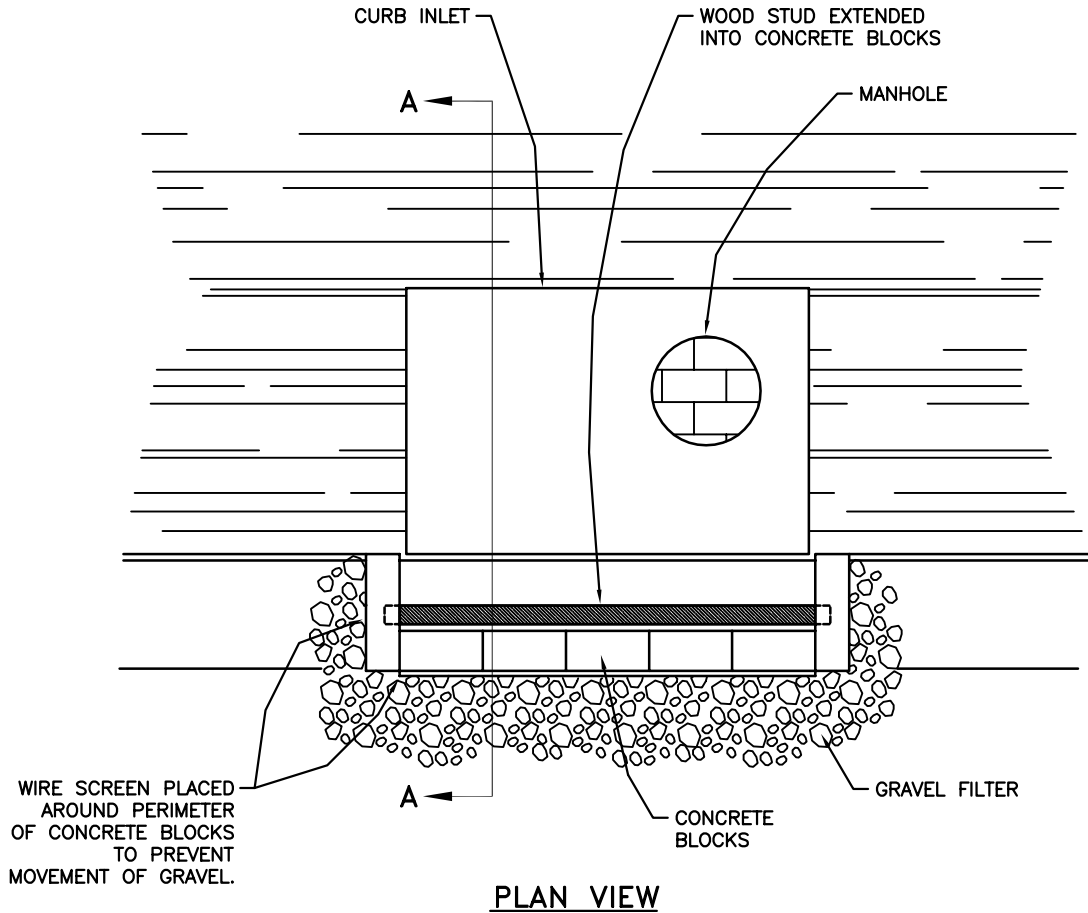
CROSS-SECTION VIEW

*TOWN OF  
FIRESTONE*

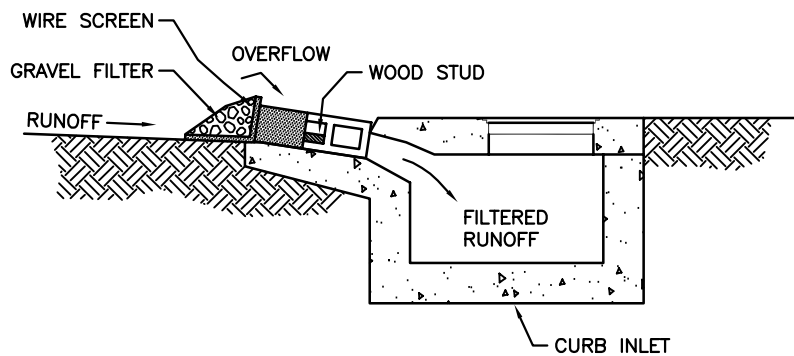
*STRAW BALE DIKE  
GENERAL INSTALLATION*

APPROVED BY: MAYOR

**TST**



NOTE:  
MILK CRATES OR BURLAP SACKS  
FILLED WITH WASHED ROCK  
ARE ACCEPTABLE ALTERNATIVES.



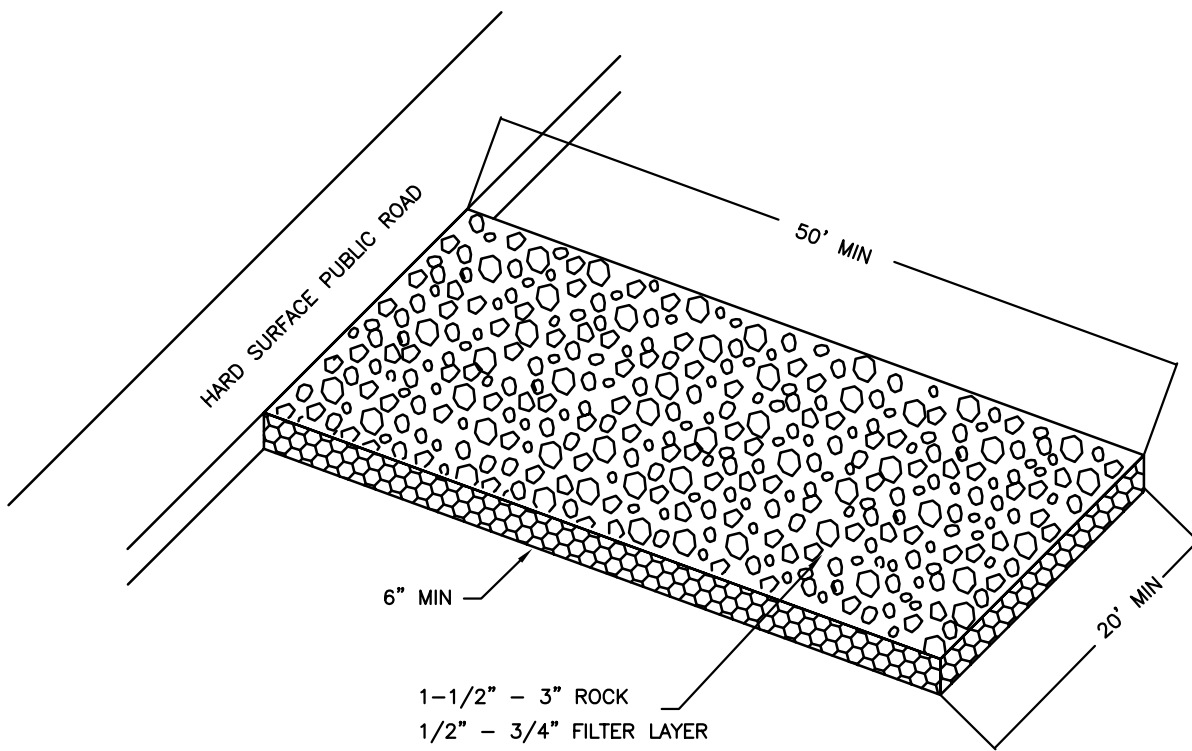
**CROSS-SECTION A-A**

**TOWN OF  
FIRESTONE**

**INLET FILTER DETAIL**

APPROVED BY: MAYOR

**TST**



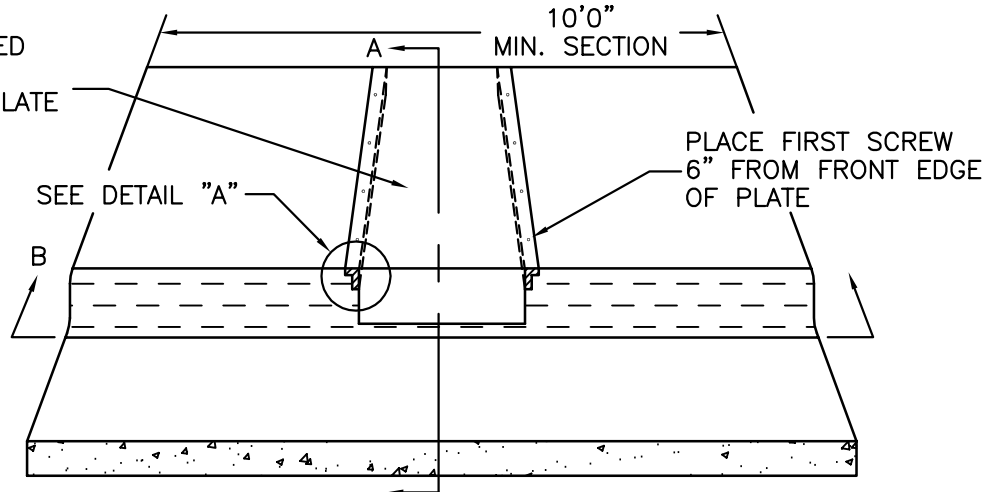
*TOWN OF  
FIRESTONE*

*TEMPORARY VEHICLE  
TRACKING CONTROL PAD*

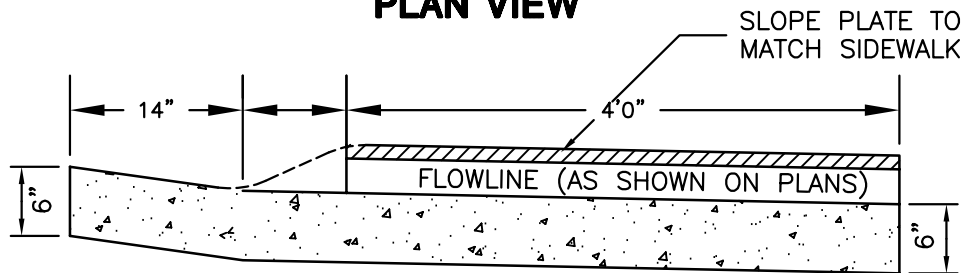
APPROVED BY: MAYOR

**TST**

5/8"x2'6"x4'0" RAISED  
PATTERN NON-SKID,  
GALVANIZED STEEL PLATE  
(AASHTO M-111)



**PLAN VIEW**



**SECTION A-A**

3/8" BRASS SCREW-  
18" O.C. WITH  
COUNTERSUNK HEAD  
FLUSH WITH PLATE

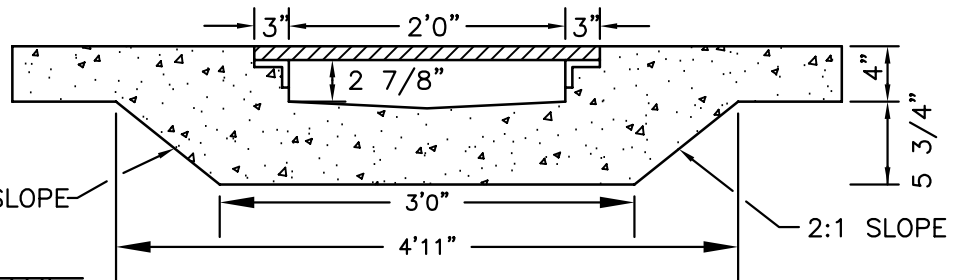
5/8"  
GALVANIZED  
PLATE

3"x2"x3/8"  
GALVANIZED  
ANGLE

NO. 3 REBAR  
ANCHOR-18" O.C.

2:1 SLOPE

**DETAIL "A"**



**SECTION B-B**

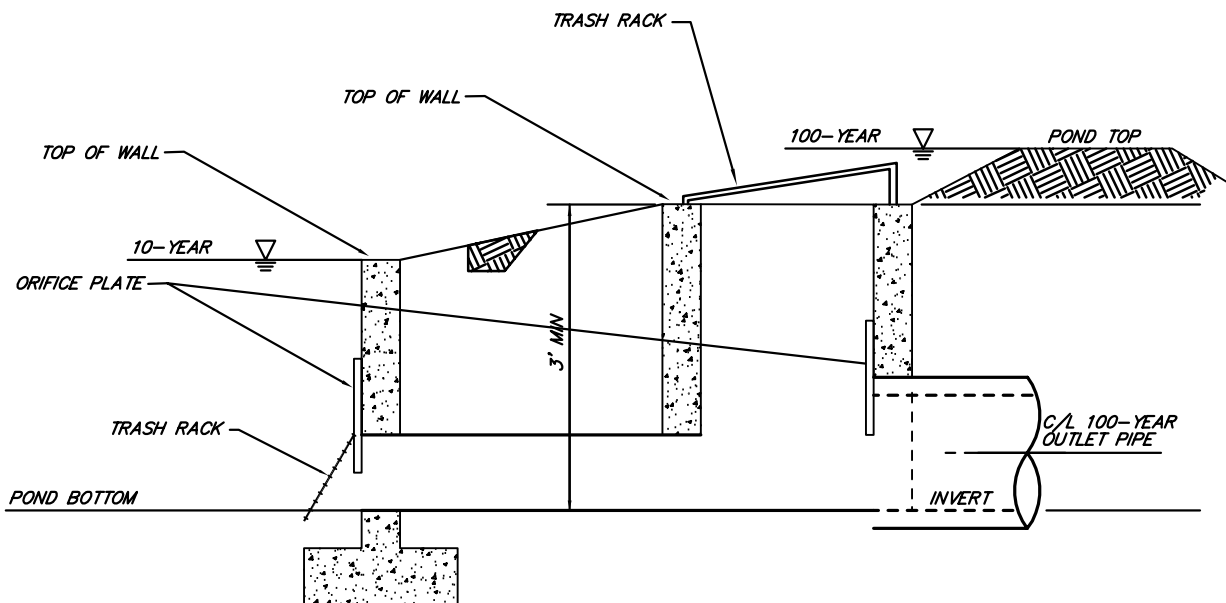
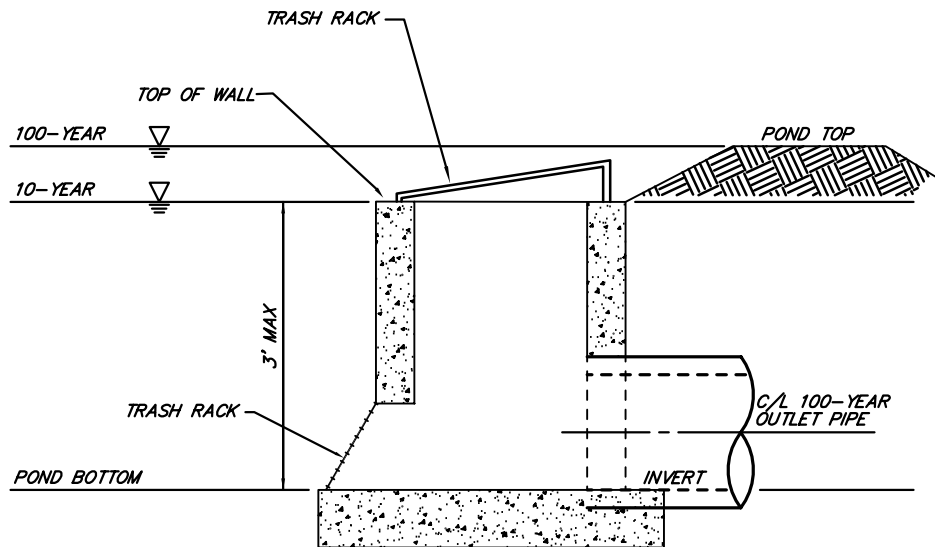
NOTE: WHEN THE CURB IS SEPARATED FROM THE  
SIDEWALK THE STEEL PLATE SHALL BE  
PLACED ON THE SIDEWALK AND THE CONCRETE  
CHANNEL (WITH 6" THICK WALLS ON EACH  
SIDE) CONTINUED INTO THE CURB AND GUTTER.

*TOWN OF  
FIRESTONE*

*SIDEWALK CULVERT*

APPROVED BY: MAYOR

**TST**

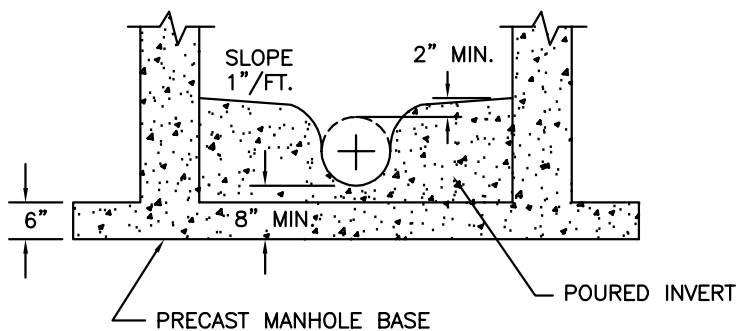
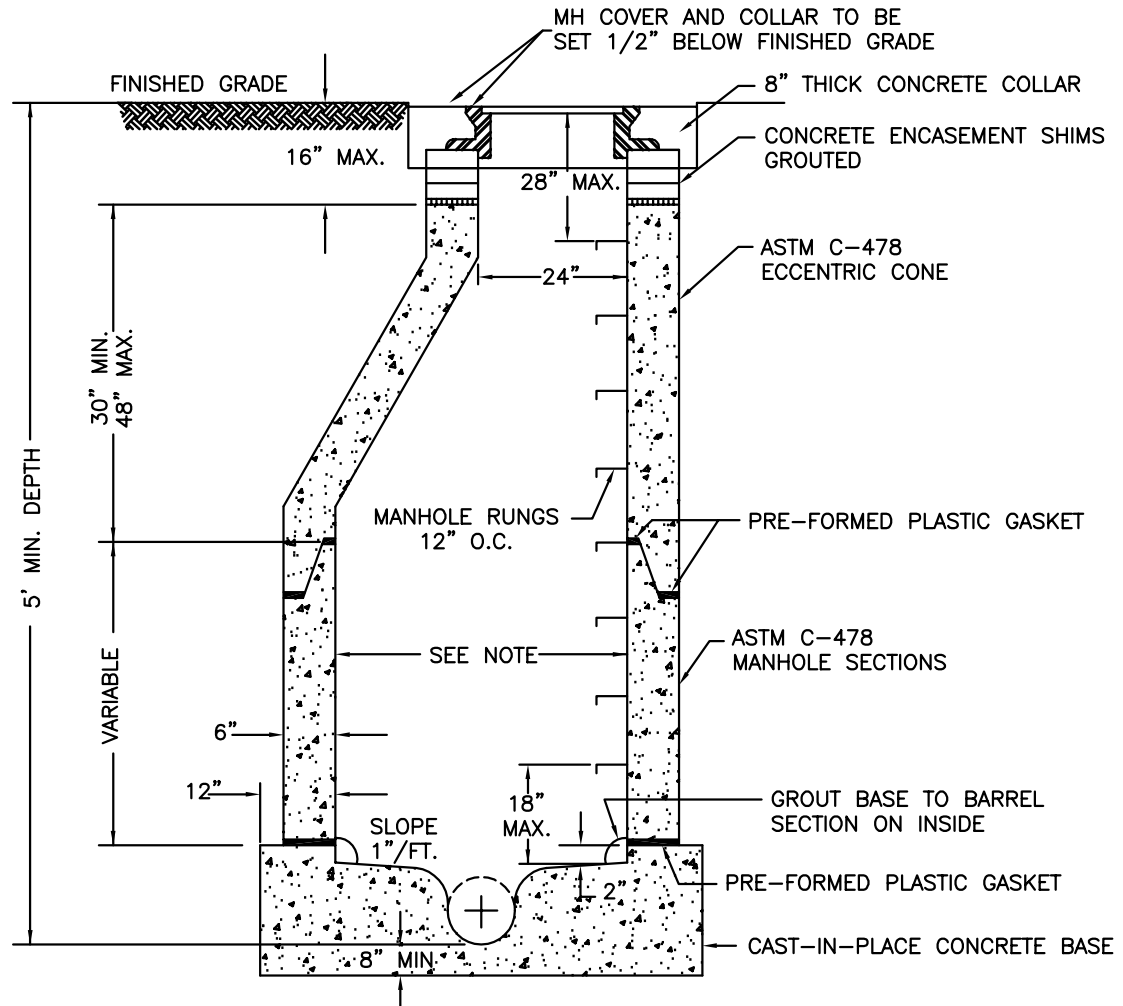


*TOWN OF  
FIRESTONE*

*OUTLET STRUCTURE  
DETAILS*

APPROVED BY: MAYOR

**TST**



ALTERNATE BASE

NOTE: MINIMUM INSIDE DIAMETER OF PIPE MANHOLE SHALL BE AS FOLLOWS:

PIPE SIZE	MIN. MANHOLE DIAMETER
15" OR LESS	48"
18" TO 30"	60"
OVER 30"	72"

NOTE: INSIDE AND OUT NEED TO BE SMOOTH FINISHED ELIMINATING ALL VOIDS. INCLUDES PRE-CAST THAT WILL REQUIRE ALL VOIDS TO BE EPOXY GROUTED.

STANDARD MANHOLE

*TOWN OF  
FIRESTONE*

*STANDARD M.H.  
DETAIL*

APPROVED BY: MAYOR

**TST**

